Silo/HDF5 Modifications for Dawn

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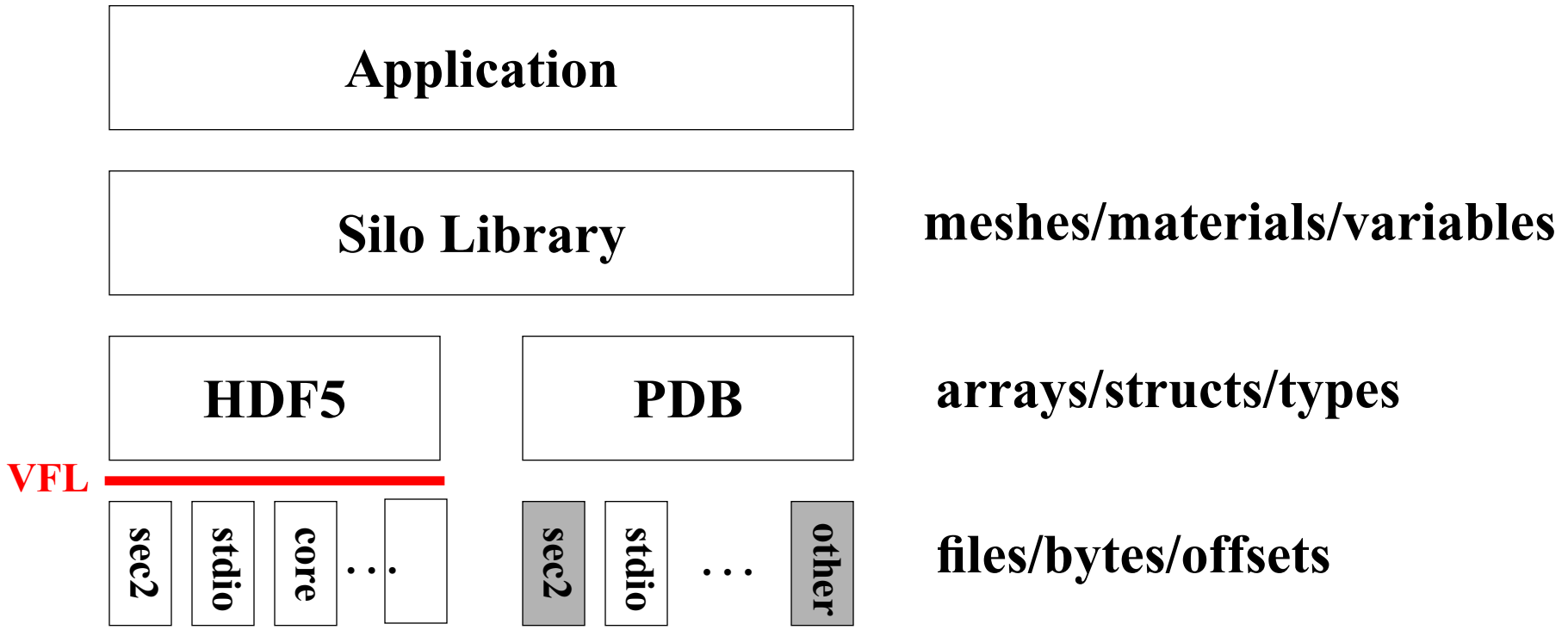
Silo Background



Benefits (= flexibility)

- *platform independent, self-describing, archiveable data*
- *random access (more true of post-processors than simulation codes)*

Drawbacks (= performance degradation)

- *metadata (data a lib writes on behalf of its caller)*
- *caller is far removed from actual disk I/O behavior/control*

Poor Man's Parallel I/O

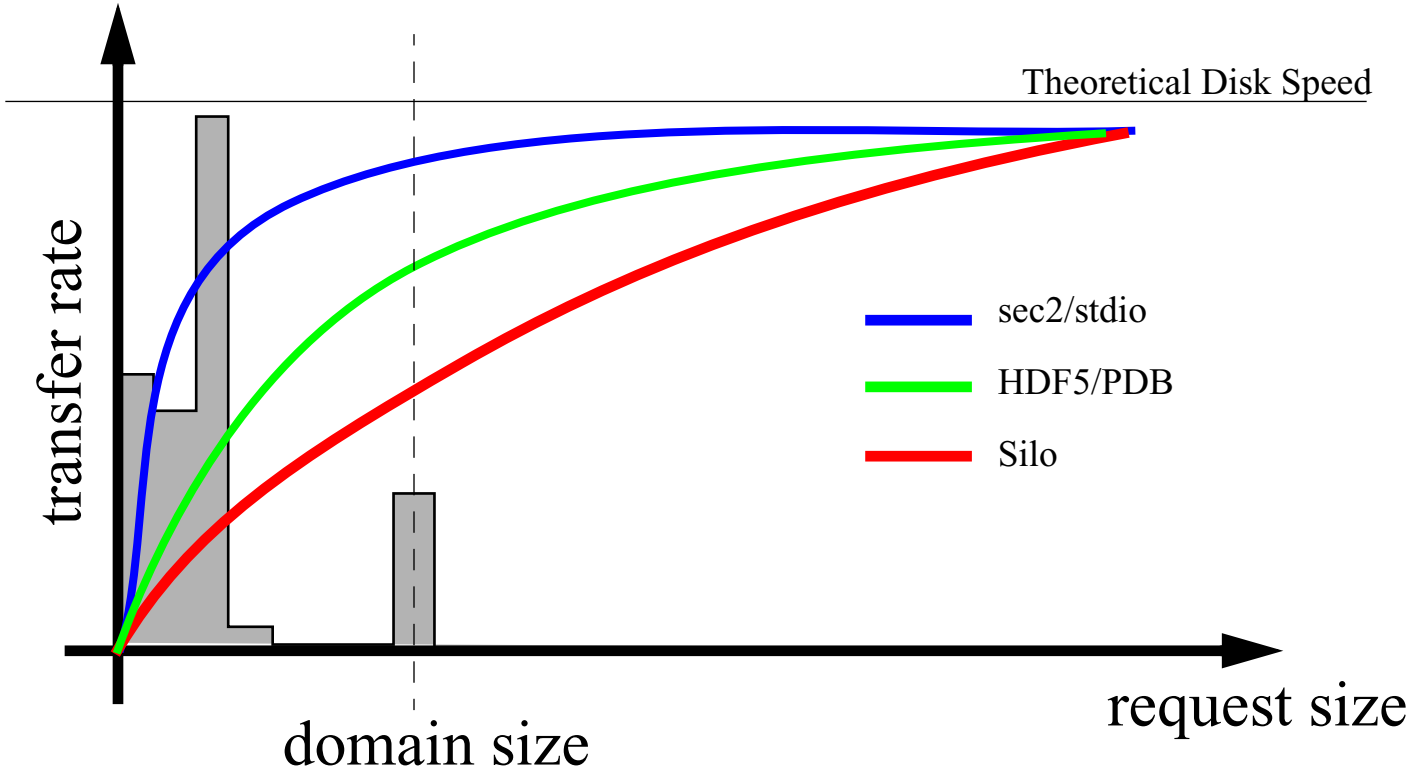
Truly concurrent, parallel I/O to a single file is problematic

- *Difficult to make perform well even for relatively simple I/O patterns.*
- *The global monolithic "whole" object is decomposed on read, re-composed on write*
- *Does not support multi-physics codes where I/O patterns are more complex*

Poor Man's Parallel I/O: Parallelism at the price of multiple files

- *Serial I/O to multiple files, simultaneously*
- *#files != #MPI-tasks*
- *Very flexible with what each MPI-task needs to do in the way of I/O*
- *Do not pay cost of "decomposing on read" and "recomposing on write"*
- *Note: Lustre can't tell the difference (almost)*

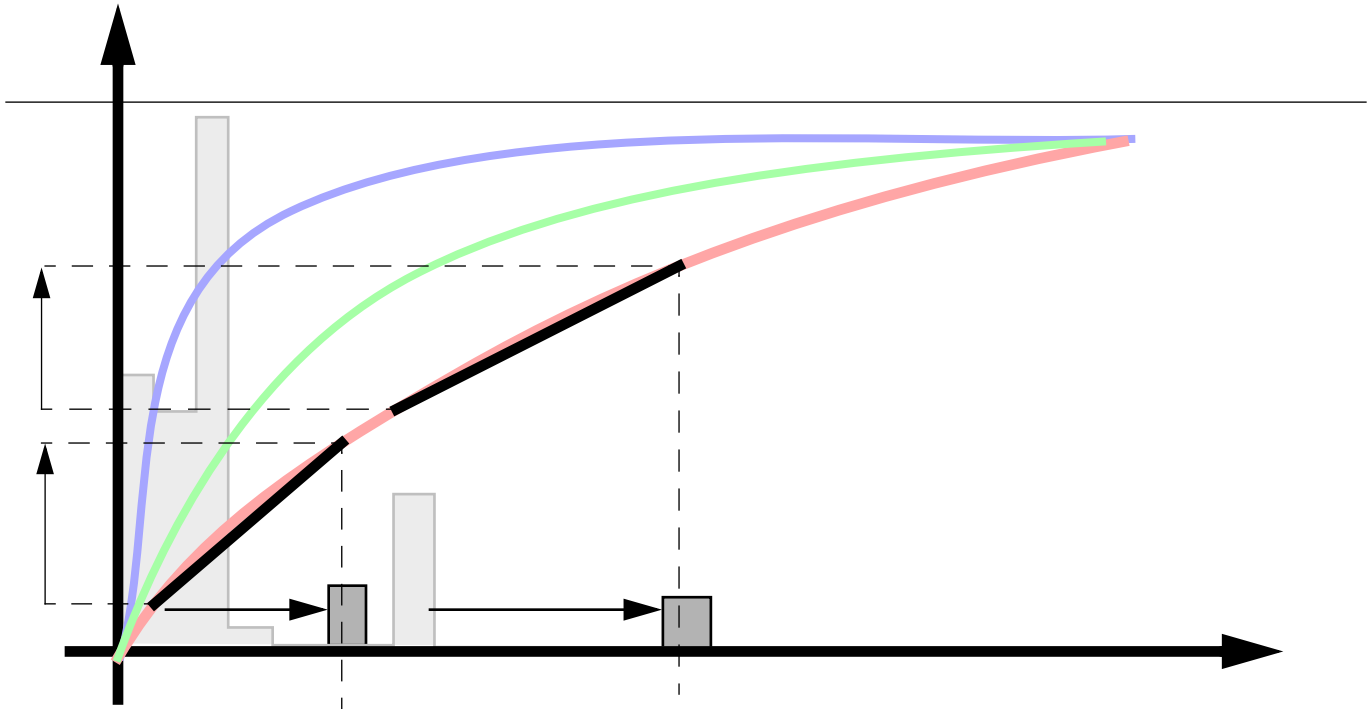
I/O Performance



Histogram of a recent Ares dump

	writes	bytes	%writes	cum.%writes	%bytes
<10^1 bytes:	48	217	20.1680	20.1680	.0001
<10^2 bytes:	41	1485	17.2268	37.3949	.0009
<10^3 bytes:	116	22474	48.7394	86.1344	.0136
<10^4 bytes:	8	30540	3.3613	89.4957	.0186
<10^5 bytes:	0	0	0	89.4957	0
<10^6 bytes:	3	1092492	1.2605	90.7563	.6655
<10^7 bytes:	22	162989412	9.2436	100.0000	99.3010

Aggregation is key to improving performance



Aggregation

- *Gather many smaller requests into fewer larger ones*
- *Need memory to do this.*
- *Try aggregating as much as possible WITHIN one MPI-task first.*
- *Failing that, start aggregating ACROSS MPI-tasks.*

Simple Aggregation Strategies

HDF5's Core VFD:

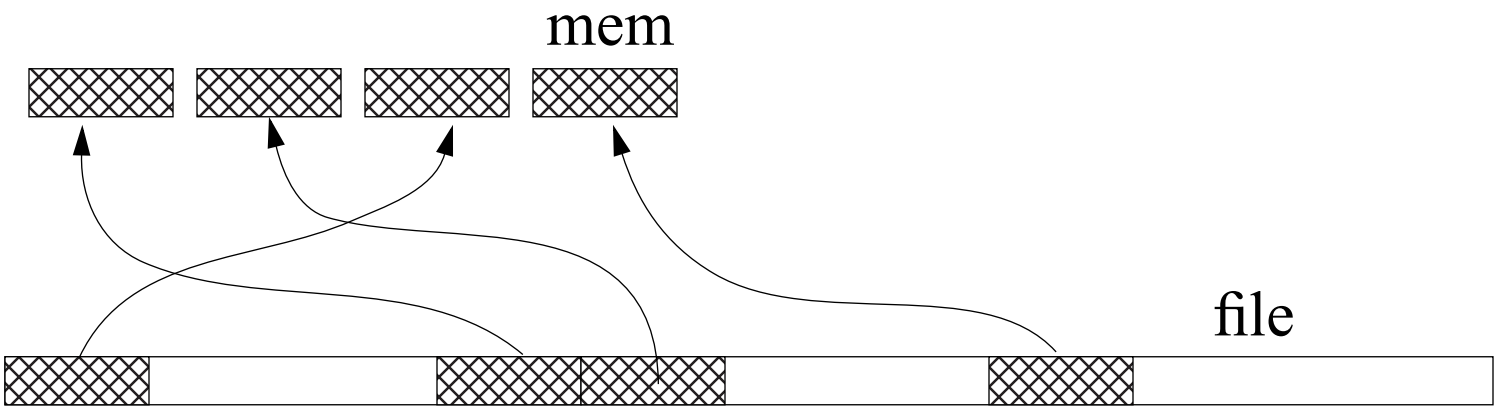
- *Stores everything to a growing buffer in memory.*
- *Writes buffer to file on close.*
- *Reads ENTIRE file to memory buffer on open.*
- *Represents upper-bound of what is possible at expense of (a lot) of memory.*
- *Only works if when code does I/O, it is dumping less than 50% of available memory.*
- *Not a good long term solution*

HDF5's Split VFD:

- *Splits data into two classes; raw and meta, writing each to its own VFD.*
- *Metadata uses core VFD, raw data uses sec2 VFD*
- *Improves performance but at price of two files on disk per one created by app.*

Silo's new Block VFD for Dawn

Breaks virtual file into blocks



Does I/O only in blocks

- *Allocates enough memory to keep N blocks in memory; uses LRU to pre-empt.*

Two Parameters set by code

- *SILO_BLOCK_SIZE (should be multiple of filesystem blocksize)*
- *SILO_BLOCK_COUNT (more is better)*

Good Values for Dawn

- *SILO_BLOCK_SIZE = (1<<20)*
- *SILO_BLOCK_COUNT=16 (16 Megabytes total)*

Other VFDs We May Write

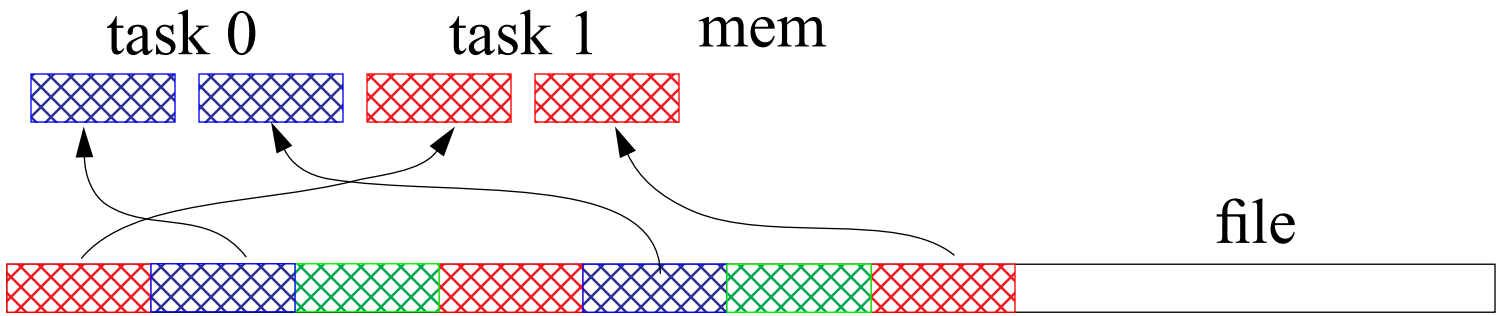
Remote-Core VFD

- *Use extra MPI-tasks just for I/O*
- *Code "writes" to memory in these extra MPI-tasks through enhanced core VFD*
- *Code goes back to compute while data drains to files from the extra MPI-tasks*
- *Should be absolute fastest as code doesn't ever wait for disk; just MPI-send(s).*

Smart-Split VFD:

- *Only one file is produced*
- *Raw data is block buffered as in new Silo VFD*
- *Metadata is kept in memory until file close, then tacked onto end of file*

Extend Block VFD to stripe across MPI-tasks



- *Let application "think" its writing to different files*
- *What if each MPI-task is writing wildly different amounts of data?*
- *May be possible to make this completely transparent to HDF5*